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THE ROLE OF SCIENCE AND TECHNOLOGY IN MODERN WAR

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INTRODUCTION

Major-General G. I. Pokrovskii, part of whose work has been cited in the RAND series of translations (T-73), occupies an important position in the Soviet development of weapons. At present he is also a professor at the Zhukovskii Academy, which is devoted to developments in aircraft.

The article that follows* was published in 1957 as part of a series of pamphlets for general adult education. Consequently, it is on a very general level. But imbedded in the mass of the familiar are a few points which, to my knowledge, are novel, or which I regard as noteworthy:

The first mention is made of the employment of satellites as platforms from which to launch nuclear weapons. (Pp. 3, 9)

Also mentioned for the first time is the desirability of strategic evacuation of cities. Furthermore, civil defense measures are accorded greater importance than usual. (Pp. 5, 7-8, 25, 26)

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* No. 29 in Series 4 of the "Lectures of the All-Union Society for the Dissemination of Political and Scientific Knowledge," Moscow, 1957, Edition 63,000 copies.

The ability of nuclear submarines to travel far under the ice is reiterated with greater specificity than in earlier writings. (P. 27)

From earlier materials one could have deduced that an important task for ground forces was the capture of mobile or camouflaged missile-launching sites. Page 35 contains explicit confirmation of this.

Pokrovskii's writings deserve serious consideration. For example, in the article written in 1956 (RAND T-73), he stated that the re-entry problem for the ICBM presented no great difficulty, and he also made optimistic prognoses about the accuracy of the ICBM.

The role of science and technology in modern war is very large and varied. In order to review this subject it is necessary to touch upon the various spheres of military affairs and the various tendencies of science and technology. Many branches of science and technology, for example, a number of departments of aviation, atomic technology, radio technology, automatization, and machine mathematics, are closely connected with military affairs.

However, in order to evaluate the role of science and technology in modern war it is insufficient to review the separate branches of science and technology: it is necessary to have a conception of the connections between development of the various branches of science and technology in contemporary war.

Some characteristic examples adduced in this pamphlet might give such an understanding. They will serve as the first step for the study of the more serious literature relating to this subject-matter.

Special Features of Modern Military Affairs

The Soviet people, led by the Communist Party of the Soviet Union, fights without surcease for peace and is assisted in this struggle by the support of all the progressive forces of the world. However, the more the wide circles

of toilers support the Soviet peace-loving policy, the more intensively the reactionary circles of the powerful countries of capitalism try to strengthen their military machine.

The military expenditures in the countries of capitalism now almost reach the very same level as during the Second World War. In the U.S.A. it is planned to expend 77 per cent of the whole expenditure part of the budget for military needs in the fiscal year 1957-1958.

The government of the U.S.A. declared its intention to locate military units equipped with atomic weapons on the territories of the countries of Western Europe, Turkey, Iran, and Japan.

The feverish military preparations of the imperialists are directed first of all against the Soviet Union, the Chinese People's Republic and the other countries of the socialist camp.

In these conditions the Soviet people and the toilers of all the countries of the socialist camp should be especially vigilant and prepared to oppose any of the schemes of the imperialist reactionary forces.

In such a situation the Communist Party and the Soviet government are forced to take measures for the further strengthening of the defense of the Soviet Union and the elevation of the fighting readiness of our armed forces.

The capitalists expend an important part of their military expenditures for the development of military equipment and, above all, the means of mass destruction -- atomic, bacteriological, and chemical weapons, long-range bombers, unmanned aircraft* and long-range rockets. A great deal of attention is devoted to the construction of submarine and surface ships with atomic motors. Work is being considered for the creation of aircraft with atomic power plants, capable of flying around the whole globe several times without landing. The question arises of the employment, for throwing atomic bombs, of artificial earth satellites which have been prepared for launching.

The rapid development of military technology in the capitalist world is also caused by the fact that orders for military equipment give the capitalists steady and very high profits on the basis of taxes squeezed out of the population. Thus, the rapid development of military technology has become an integral link in the capitalist economy.

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* The Russian term is samolet-snariad. We have no special word for this term in English, but it means an air-breathing, usually subsonic missile, with ranges up to intercontinental; one of the common American types is the Snark.

The modern attainments of military technology lead to new potentialities for the conduct of war. The powerful vehicles of atomic weapons permit the delivery of powerful and surprise blows to any portion of the globe. Transport aircraft, particularly helicopters, and air transport in general, furnish the opportunity to carry out rapid maneuvers with ground troops. The development of military technology makes modern war completely unlike all past wars. For example, Soviet aircraft can deal blows, particularly with atomic weapons, far from the borders of our country; Soviet long-range rockets can also be employed to carry atomic weapons.

The ceaseless growth in the potentialities of the Soviet economy, particularly the great attainment in development of heavy industry, have permitted the arming of our army, air force and naval fleet with first-class military equipment. Therefore, to understand modern military affairs it is not possible to assume only the experience of past wars. A correct evaluation is required of all the conditions influencing the modern methods of the armed conflict.

The role of technology in the conduct of military operations has risen extraordinarily. In this connection the fighting power of the armed forces, as never in the past, now depends on the attainments of technology, on the potentiality

for the mass production of new kinds of weapons and on the level of the technological preparation and the education of the many-millioned masses of the population.

Moreover, one of the essential peculiarities of the future war is the loss of the sharp difference between the front and the rear (in their former meaning). From this flows the necessity for a far greater reliable defense of the rear from enemy aerial blows than was the case in the past war. Therefore, the preparation of cadres for our armed forces through the DOSAAF system and the preparation of the population for anti-aerial and anti-atomic defense and the general dissemination of military knowledge, demand in contemporary conditions the elucidation of many scientific and technical questions. Contemporary science and technology are the broad basis of military knowledge.

The question of the role of science and technology in modern war is one of the key questions in military affairs.

The founders of Marxism-Leninism always devoted serious attention to military matters. V. I. Lenin taught that any revolution only became worthwhile when it was able to defend itself. The social structure of the government plays a decisive role in the organization of the armed forces and in their military preparation. Therefore, in order to under-

stand the character of the armed forces and the possible means of military action, it is necessary to study their class nature and to understand the political goals for whose attainment they were created. From this it follows that the study of the development of human society -- historical materialism -- is the basis without which it is impossible to understand the development of military affairs.

In capitalist countries the reactionary political forces are forced to hide from the people the goals of the wars that they are preparing and to make unobjective, unscientific explanations of the nature of war, thereby concealing their aggressive aspirations. On the contrary, the goals for which the armed forces of the Soviet Union and the countries of the socialist camp were created are clear to all the progressive forces of the world and therefore our Soviet teachings on war and the armies are always objectively correct. They furnish the opportunity to look boldly into the future and to evaluate the character of a possible future war correctly.

It is possible to attain victory in modern war only with the mobilization and the correct employment of all the economic potential of the government. In this connection a high level of development of heavy industry which assures the production of modern weapons systems and military equipment has special

importance. To build military aircraft, ships and tanks, high quality metals in significant quantities and complicated electrical motors and powerful power plants are required. Moreover, it is necessary to insure the rapid mastery of the production of new kinds of military equipment....

The Communist Party and the Soviet government, which direct the efforts of the toilers toward the comprehensive development of heavy industry, assure the military might of our country and the supply of the Soviet armed forces with all the newest kinds of military equipment in the necessary quantity.

As an example, it is possible to refer to the rapid and successful development of our aircraft production and the still more rapid creation of atomic production which permits the furnishing of our armed forces with various kinds of atomic weapons and also the vehicles for those weapons as, for example, long-range rockets and transcontinental rockets.

With the modern potentialities of the military employment of aircraft and long-range rockets, blows can be dealt to the vital centers of governments, even those located in the deep rear. Therefore, the questions of the location of industry and the important natural resources (oil, for example) on

the country's territory have great significance.

The Physical and Mathematical Sciences in Military Affairs

The unprecedented development of military technology in our day is connected with the very rapid mastery of the new discoveries in the natural sciences.

The creation of the modern matériel and technical equipment of the armed forces can be secured not only by the well organized work of industry and the military ministries, but also by the intensive efforts of a large number of scholars and engineers who are included in the wide network of special scientific institutes, bureaus for construction and experimental testing grounds.

The physical and mathematical sciences, particularly the discoveries in physics made in the last decades, have especially great significance for military technology. Thus, the development of work in the spheres of electrical and magnetic fields led to the creation of radio technology which provides for communications between the armed forces and the command, for the action of equipment for automatic guidance at a distance, and also for the means for radar, reconnaissance and detection of the flying and sailing objects of the opponent.

The employment of the energy contained in the nuclei of the atoms of several chemical elements has permitted the construction of atomic weapons of unprecedented might and the construction of military ships with atomic motors and the approach to the creation of atomic aircraft.

The development of the technology of metals, of the liquid fuel jet engine, of astronomy, of ballistics, and of aerodynamics led to the creation of the long-range rocket capable of flying across an expanse of several thousands of kilometers and of rising to heights of more than a thousand kilometers, and has also led to artificial earth satellites. These satellites, together with their scientific value, also have military significance. From them it is possible to observe the opponents' territory and to throw atomic bombs on that territory.

Often research in physics, which at first glance seems to be of very narrow and special significance, when it works out in practice accomplishes a revolution in technology and exercises an influence on military equipment. As an example, one might refer to the research in semi-conductors, for example, the crystals of germanium, which have the quality of conducting electrical current of a very low order. Research has shown that the semi-conductors can replace electronic tubes in complex radio technical and electronic instruments. This

permits the making of both very compact and, moreover, stable and reliable radio apparatuses. From this arise great opportunities in the manufacture of guided and automatic means of destruction and other important types of modern military equipment.

Even such sciences as celestial mechanics and astrophysics have now acquired decisive significance for military affairs. Celestial mechanics until recent times has been interested in calculating the motion of celestial bodies. Now this science is employed to calculate the flight of long-range rockets and artificial earth satellites. Astrophysics is concerned in part with the study of the physical characteristics of the cosmic expanse. Information about these characteristics is now used in order to foresee all the conditions of the working of the apparatuses of artificial satellites and rockets. It is necessary to know how cosmic rays would act upon this apparatus, what the temperature of the rockets would be when heated by the sun, what would be the probable deviation of the rocket from small and larger meteorites, and what would happen in the event of their collision with a rocket. The research of astrophysicists regarding the condition of the matter within the sun and the stars at temperatures of millions of degrees and pressures in billions of atmospheres

have great significance for the correct understanding of the essence of the atomic explosion.

The light and the radio waves emanating from stars, planets, and cosmic nebulae can be employed for the automatic guidance of very long-range unmanned aircraft, thus assuring very great accuracy in the guidance of their flight to a given target.

Mathematics and the associated theoretical mechanics have long had essential significance for the development of military matters. Moreover, many questions of mathematics and mechanics have received their scientific development in connection with the solution of the tasks of artillery fire. Thus, the development of mechanics and theoretical mechanics was partially caused by the demand of military considerations and has had essential significance for it.

At the present time the firing of guided and self-homing missiles has acquired a very great role. They have special apparatuses permitting the change of the direction of the flight of the missile with the calculation of hitting the target as accurately as possible. This is attained in various ways. One can place instruments on the missile which like a human eye follow the target and guide the missile to it. It is also possible to follow the target from the point of the

discharge of the missile and guiding the missile from a distance, to direct it to the target. In order to select the best method of guidance for the missile it is necessary to compare all possible means.

This is accomplished on the basis of a new sphere of science called cybernetics, the theory of the guidance of machines and mechanisms with the assistance of automatic devices. This science, at the present time, has very great significance for the automatization and mechanization of peaceful production. However, its significance is no less great in military matters, too.

Recently machine mathematics has acquired a very great significance for military matters. At the present time the manufactured electrical calculating machines permit the solution of unusually complicated mathematical and logical problems with unprecedented speed. Such machines are employed for the automatic guidance of the firing of anti-aircraft, naval, and aerial artillery and provide for tracking of an opponent's aircraft.

Calculating machines of a different type can be employed on a large scale for the calculation of the supply of matériel, equipment and money to the troops. Finally, machine mathematics can be widely employed to analyze past military operations and in the planning of new operations.

However, no matter how accurately the calculations are made they cannot, as a rule, reflect all the circumstances influencing military operations and the action of various kinds of military equipment. Therefore, it is impossible to speak of the authoritative solution of the various mathematical tasks connected with military matters and the armed conflict. It is customary to speak of the degree of the probability of the solution of the tasks before us. If artillery fire is conducted against a given target having relatively small compass, for example against a tank, then not every shell hits the target. If very many shots are made, then, it is possible to establish that, say, only half of these will hit the target. This means that the probability of the impact in such conditions is equal to 50 per cent. It is possible to speak of the probability of the resolution of the most varied military tasks, for example, of the probability of the discovery of the opponent's aircraft in a given zone of the sky, and also of the probability of destroying this aircraft in the aerial battle.

Thus, the theory of probability which gives the theoretical basis for such calculations acquires even greater significance at the present time. The theory of probability has already been long employed in artillery and in bombing

aviation. Now it begins to be widely introduced into the military art as a whole.

It is indubitable that the development of new technology does not reduce the role of the man in the armed conflict, but, on the contrary, elevates his role because only the educated soldier and military leader with all-round development and instilled with a consciousness of his military duty can completely master modern military technology and the organization of battle and attain victory over the opponent in battle.

A special field in the physical and mathematical sciences which has developed rapidly in recent times is meteorology, the study of the atmosphere and weather. Meteorology at the present time has very great significance for aviation. For example, by studying the upper layers of the atmosphere it is possible to establish the so-called wind currents, which in certain portions of the earth have a fixed and relatively established character. This can be employed for military purposes by directing to a quite significant height (20-30 kilometers) and guided by radio, aerostats with an apparatus for taking aerial photographs or even for bombing the opponent's territory. The first attempts in this direction were made by the Japanese during the Second World War. They sent aerostats with combustible materials to American territory and did some harm to the U.S.A. and Canada.

In 1955-1957, aerostats with aerial photographic equipment were sent from the eastern shores of the U.S.A. to the air space of the U.S.S.R.

Recently the ideas of the so-called "meteorological war" have arisen in the United States. Some authors regard the creation of artificial drought in the opponent's territory as one of the most effective means of such a war. Naturally, this is still a rather ill-defined scientific problem. Nonetheless, it is necessary to be prepared for various surprises even in this sphere.

Chemical, Biological and Medical Sciences

The chemical sciences have the purpose of the study of the laws of the formation and transformation of the molecules from which all the varied substances surrounding us are constructed.

The role of chemical sciences is also very significant in military matters. First of all, chemical weapons should be referred to which are based on the employment of military chemical substances for the destruction of people. At the present time very effective substances have been made of which small quantities are adequate for destruction of people. Military radioactive substances which are close to them are also employed. During the Second World War military chemical

substances were not employed for a number of reasons and military radioactive substances were then not prepared in significant quantities. Therefore, experience is lacking for the employment of these substances of mass destruction in conditions of modern war. However, there is no basis for hoping that in the future, too, such substances will not be employed. The theoretical and scientifically based forecasts should give the military specialists and the whole population a clear picture of how a chemical war might develop and what is the best system for the defense of troops and population from chemical and radioactive substances. Even one of these questions demands quite a deep knowledge of chemistry for a review of the military problems. Particularly, broad circles of the population should know the means of defense from the mass means of destructions based on the employment of the newest attainments of science.

The great role of the chemical science, in assuring the production of various remedies and medicinal preparations is important for the struggle with the epidemics and the healing of wounds and illnesses which arise in wartime conditions.

The chemical sciences assist in the development of special kinds of production connected with the defense of the country, for example, the production of gun powder and

explosives substances. Recently the demand for great quantities of alcohol and liquid oxygen employed in rocket technology has risen sharply.

In the event of war, the replacement of materials that are in short supply or no longer importable, and [the provision of] substitutes of adequate quality acquire decisive significance. It is known what a great role, for example, the production of synthetic rubber and liquid fuel played in the Second World War. What is especially important is the development of the production of synthetic rubber, since natural rubber is attained, as is known, in only very limited regions of the earth's surface.

Chemistry has significance for many spheres of the military art. As an example, one might point to the problem of preventing the corrosion of items of military equipment as, for example, aircraft.

The biological sciences play a great role in military medicine and particularly in the nutrition and water supply of the troops.

In recent decades, bacteriological weapons have been developed based on the employment of bacteria which would cause great epidemics of infectious diseases. The scientific analyses of the potentialities of the employment of bacteriological weapons and the means of defense against them has

very great significance in strengthening the defensive capability of the country.

Technical Sciences

Modern military technology is inextricably connected with whole areas of civilian technology employed in production, transport and agriculture. Therefore, all the technical sciences have an essential significance for military matters. Let us look at a few examples.

The development of the means of destruction, in particular the atomic weapon, has led to the development of various kinds of vehicles for this weapon. The varied guided missiles fall into this class. Automatization and guidance permit the direction of a missile in many cases more accurately and more rapidly than a human being could do it, especially in the tense conditions of a military situation. The apparatus for automatic guidance permits the conduct of the particular shell according to a definite program to find the military target and to destroy it with precision.

Anti-air guided jet missiles have a great significance in anti-air defense. This is connected with the necessity of the interception and destruction of the vehicles of atomic weapons directed by the opponent. Ordinary anti-aircraft artillery and even fire directed from aircraft cannot resolve this task with adequate reliability.

An example of an anti-air guided missile is the Nike missile adopted into the American weapons system. It homes on the target by a radar system of guidance and can destroy aerial targets (planes with people, and unmanned planes), flying at a height of more than 20 kilometers. The slant range of the missile is about 30 kilometers. Despite a quite perfected system of guidance, the Nike cannot always hit the enemy aircraft. In the majority of cases it flies by it. In such an event a proximity-fuse operates which causes an automatic explosion upon the close proximity of the shell to the aircraft. Upon its explosion in various direction fragments are dispersed which destroy the target. According to the report of the foreign press the probability of destruction of an aircraft of the B-17 type at a height of 10 kilometers by the Nike missile is about 65 per cent.

The missiles are discharged from special platforms.... The Vice Minister of Defense of the U.S.A. Quarles, in his September 29, 1956, speech noted that atomic charges for the jet-guided missiles Falcon and also for the Nike missiles had been introduced into the armament of the air forces. A variant of Niko with an atomic warhead, which has received the name Nike-Zeus, has been designated for the battle with long-range rockets.

The anti-air and sea missiles, Terrier and Talos, can also carry atomic warheads. The missiles of this type are now replacing conventional artillery on most of the battleships of the American fleet. For example, the magazine Aviation Week of November 7, 1955, showed that on the American heavy cruiser Boston, the large-caliber gun turrets had been replaced by dual launching platforms for Terrier missiles.

In some countries automatic unmanned fighter planes have been developed for anti-air defense. The French pilotless fighter Charançon VI, armed with 12 jet missiles, is in this class. The fighter has a television apparatus which permits the operator who is on the ground to see about what a pilot would see. This eases the guidance of the fighter at a distance. The maximum speed of Charançon VI exceeds 2,000 kilometers an hour and its ceiling is 20 kilometers.

For delivery of blows against particular strategic targets, together with conventional aircraft, bombers may be employed which carry long-range rockets, as may also unmanned planes with a flight range from several hundred to 5,000 kilometers. These machines ordinarily fly at a very great height. Automatic apparatus conducts them according to an earlier established course and brings them to the target.

Instruments can conduct the unmanned plane according to a fixed course, oriented, for example, by the stars. In this event several telescopes are placed aboard the airplane which keep in the center of the field of vision certain stars during the whole time. The telescopes automatically swing in accordance with the movement of the plane and the rotation of the earth. Such a system is called astro-navigation.

Examples of an American unmanned plane are the Snark and the Matador.

The rapid development of aircraft, jet motors and rocket technology, which has great significance in modern military matters, is particularly connected with research into the laws of the motion of bodies in air with great speed and also the motion of gases at different speeds and temperatures and pressures. With this purpose very powerful experimental devices have been made. First place among these is occupied by the aerodynamic tunnel in which a rapid movement of a body in the atmosphere is produced. The object studied -- an airplane, rocket or missile -- is placed in the tunnel which artificially creates a flow of wind of the required speed.

The fighting power of the air fleet and consequently the potential capability of the country is closely connected with the work of well equipped aerodynamic scientific research

and experimental institutes. In military matters, other technical sciences which are concerned with research into and the elaboration of the means of production of light, and especially stable metal for aircraft, for armoring tanks and naval vessels, for military bridges, shells and motors, have decisive significance.

The engineering of powerful and light motors for aircraft tanks, military ships and automobiles, for long-range rockets and for many other military machines plays a very great role. As a rule, the increase in the power of a motor is connected with the elevation of its working temperature. However, in order to raise its temperature it is necessary to create a motor with metals resistant to heat. Heat-resistant metals also have very great significance in the creation of light, compact and powerful atomic motors for military ships and especially for aircraft.

Recently the necessity for getting heat-resistant metals required for building aircraft flying at high speeds and heating greatly because of friction with the air has arisen. In this connection, the technology of metals and other materials has acquired a tremendous role in the military affairs, and now the defensive capability of the country is determined in part by the production of highly stable heat-resistant metals and other materials.

Energetics and thermotechnics has great significance for military matters. First of all because very powerful heat engines are required for many military items. For example, the power of the jet motors of a heavy bomber reach a hundred thousand horsepower and even exceed it. The power of liquid-fuel jet motors for long-range rockets is even greater; at the end of the journey, during which the motor drives the rocket to a speed of several kilometers a second, it attains approximately a million horsepower. Despite this tremendous power the motor weighs, in this case, no more than several tons. There is no other sphere of power in which such highly concentrated power is employed as in military long-range rockets.

Electronic equipment plays an exceptionally important role in military technology. Modern military aircraft, ships, tanks, radio stations, fortification systems, are saturated with mechanisms and apparatuses working with the assistance of electricity. As an example, one can adduce the centralized electrical system of guidance for heavy artillery of a bombing airplane which permits a single person to direct all the artillery instruments of an aircraft.

Radio technology and electronics technology play an even greater role. In the near future one can expect the development of the struggle with, on the one side, the means of

reconnaissance and guidance operating by radio waves, and on the other, the means of interfering and disorientation of the opponent also employing the radio waves. The struggle in the ether and for the ether will have tremendous significance in the arms struggle of the near future.

It is difficult to list all the technical sciences which play a great role in the development of military technology and military matters. We view only a few of these. For example, optics and illumination engineering. Optical equipment for observation, binoculars, stereostopic telescopes, and photographic equipment are widely employed in military matters. No less widely known are special military optical instruments, artillery sights and bomb sights. Optical equipment working on infrared rays is being employed ever more widely and also instruments transforming very weak infrared rays into powerful visible rays. Such instruments are called electronic optical transformers. They permit seeing in the dark by the illumination of an infrared projector or without any illumination by the weak light of the stars and the illumination of the nightly heavens, even in the case when the action of these light sources is weakened by clouds.

Spectratroscopy is also widely employed in military affairs. That is, that department of optics which is interested

in the spectral composition of light, that is the distribution of the energy of light in various wave lengths. Spectratroscopy is necessary for studying colors adopted for camouflage and for working out ways of overcoming the opponent's camouflage. Acoustics, the science of sound, is widely employed in the search for submarines and observation from submarines of surface and sub-surface vessels. The particular department of acoustics which is concerned with the dissemination of sound in water is called hydro-acoustics. In hydro-acoustics not only sounds in hearing frequency are employed, but also ultra-sounds intercepted by the proper instruments.

Hydro-acoustical means are also employed for the guidance of naval torpodoes and other items in the naval fleet from a distance.

The development of the means of destruction leads to the necessity of the construction of various shelters and refuges for the defense of the troops and the population. These constructions can be very different, beginning from the simplest trenches and ending with complex underground installations, reminiscent in their construction of subway stations.

For the building of shelters and refuges various machines and earth-moving equipment are necessary. All these technical means should operate very quickly in wartime conditions

and harmoniously. Therefore, the prior organization of work in construction sites plays a decisive role.

Modern war is a war of maneuver; in the preparation of conduct of military operations the great masses of men, equipment and materials will be employed. This creates the necessity of the rapid construction of roads, bridges, over-passes and the wide employment of mechanization and automatization.

The modern army is very heavily equipped with motors requiring a great deal of liquid fuel, benzene, kerosene, oil, alcohol and lubricating oil. For the transport of these liquids in many cases, it is necessary to put them into long pipelines crossing rivers, mountains and often even wide ocean expanses. The construction of pipelines demands scientifically based calculations and preparatory engineer reconnaissance.

Roads, bridges and other communications are necessary, not only in the frontal zone; they should also be developed in the rear for employment in the event of necessity of the rapid dispersion of the population of great cities and the removal of economic and cultural valuables. Such a dispersal can also be caused by the necessity of avoiding blows from enemy aircraft and long-range rockets.

In this connection the necessity of having energy sources in many centers of the country can also arise. For this

purpose one should create mobile electric stations, particularly railroad and automobile energy cars of varied power. The mobile atomic electric stations created in the U.S. for army needs represent something very interesting.

Military sea and river transport are important links in modern warfare. In the conditions of the oceans surrounding the Soviet Union, ice breakers and ships of ice breaker type are important in the military sea fleet and military river transport for supporting communications throughout the whole year. In our Arctic and also in the Antarctic, atomic ice breakers are very essential, being capable of navigating in ice without returning to base for several years. By decision of the XX Congress of the Communist Party of the Soviet Union the first atomic ice breaker is already building in the Soviet Union, and has received the name Lenin. Atomic ice breakers and other ships can be viewed not only as a means for securing transportation, but also as mobile electric stations which can furnish energy over an extended period of time without the transport of fuel and other materials.

Atomic submarines for transport in the Arctic and Antarctic which are capable of traversing significant distances under the ice and supporting communications independently of the condition of ice represent a significant interest.

In conclusion, it should be noted that one must not confuse such varied aspects of the problems reviewed as technical sciences used for military purposes and civilian technology employed in war (construction techniques, transport, etc.). Practically any variety of civilian technology will be employed in one degree or another for defense needs. Moreover, many sciences, including technical sciences which are necessary for military needs, receive a specific military direction as a result of which a special "military branch" of this science is created. Thus, for example, "military optics," "military hydro-acoustics," are employed for exclusively military tasks.

Military Technology as a Single Whole

The powerful atomic charge of tremendous destructive power by itself has no significance in military affairs. This charge must be delivered to a military target. Consequently, it is necessary to have the appropriate air vehicle. However, it is unknown in advance whether an airplane is the best vehicle for such a charge. Perhaps it is better to employ rather than an airplane piloted by people an automatic unmanned plane, but perhaps even this decision is not the best. This must be compared with other possible decisions, for example, the employment of long-range rockets for this purpose. Finally, one can employ an aerostat borne by atmospheric currents at

a height of several dozen kilometers as a vehicle. Comparing all these vehicles one must establish, first of all, the accuracy with which they can deliver the atomic charge to the target. Apparently an aircraft with people can carry out this task most accurately. For the employment of an unmanned aircraft and long-range rockets, one needs to know beforehand the map position of the target to be destroyed and, moreover, the map should be sufficiently accurate and correspond to the actual location of the target on the ground.

One should also take into account the opponent's defense which may employ various kinds of weapons -- aircraft, anti-aircraft, guided missiles against the vehicle for the atomic charge. In addition, the opponent may have the capability of making more difficult the search for the target by employing various means of camouflage, for example, the creation of false targets. The opponent may also employ powerful jamming which makes more difficult guidance by radio or the employment of radar aiming. Obviously, the vehicle of the atomic charge should pass through all the barriers of defense and the counteraction of the opponent.

Besides these complex and varied tasks other quite different tasks must be resolved. In order to clarify the costs of a complex of means, it is necessary to study the

production potentialities of various branches of industry and the existence of adequate supplies of raw material for the production of military equipment. Without the accurate evaluation of the economic and production question, it is completely impossible to assure the successful conduct of military operations.

Finally, it is necessary to determine what targets should be destroyed first; what influence the destruction of one or another target has on the course of the war; what will be the political significance of one or another blow against the opponent's rear. These questions pass far beyond the limits of particular technical or scientific tasks. Here it is necessary to employ the conclusions of many branches of science and technology, but all these branches are auxiliary, and military science which studies the means and methods for the attainment of victory serves as the basic science uniting them.

Military science is a system of knowledge necessary in modern conditions for the preparation for the defense of the country and the conduct of wars as a whole. It includes questions of the military art and is concerned directly with the armed conflict and the questions of the attainment of victory. Together with working out the questions of the military art and also the organization, equipping and training

of the armed forces, military science is concerned with the study of the complex of social-political, economic, moral and other factors influencing military affairs as a whole.

Thus, a military science goes far beyond the limits of problems directly connected with military technology, but it is precisely for that reason, therefore, that military science serves as a basis for the evaluation of separate spheres of military technology and also of all the sciences upon which this technology is based.

Only on the basis of military science can one establish the interrelationship between the various forms of military technology which show the path to the harmonious combination of the various types of arms and their most effective employment in warfare.

The various forms of military technology constitute a single system in which the following branches enter in part:

1) Weapons systems -- the combination of the means for the destruction of the opponent;

2) Means of defense from the destruction of people and equipment; fortification, anti-gas and protective clothes, passive measures of air defense, etc., are relevant here;

3) Reconnaissance -- radio, technical instruments, optical instruments of observation, photographic, especially air photography and other apparatuses;

4) Means of camouflage -- camouflage nets, costumes, clothes, decoys, decoys representing aircraft, tanks, guns, etc.; for distracting the attention of the opponent;

5) Means for communication and direction of troops -- radio equipment, wire communications, encoding and decoding machines, etc.;

6) Transport means -- auto transport, air and sea transport, means for repair, machines for road and airdrome building, etc.;

7) Means of obstruction and the struggle with them -- sea and land mines and chemical obstruction.

In addition, there are many new means of military technology, not employed directly in the struggle with the opponent, but possessing very great significance for the assurance of military operations.

The various means of military equipment can be employed in equal degree for offense or defense. Therefore, it is difficult to draw a clear line between the aggressive and defensive forms of military equipment. However, every aggressive means is opposed by one or several defensive means. The more the means of destruction and offense are developed, the more the corresponding means of defense are extended.

The development of artillery led to the development of fortifications and particularly the armor defense of immobile and mobile equipment as, for example, tanks and ships.

The development of the means for observation and reconnaissance led to the development of camouflage means.

The development of military transport and the motorization and mechanization of troops has led to the creation of various obstructive means as, for example, the mining of localities.

Even such powerful means of destruction as long-range rockets carrying atomic warheads, judging by recent statements in the foreign press, can be repelled.

Work is being conducted on the creation of automatic systems of anti-rocket defense which discover the rocket of the opponent with the assistance of radar and assure its destruction at great height by special guided missiles.

The means of offense and defense usually do not appear simultaneously. For example, in recent decades aircraft have developed noticeably more rapidly than the means of anti-air defense. However, such lagging behind can be liquidated by correct planning of scientific and engineering work.

In recent years, in reality, we have created conditions in which it is possible by means of the correct development of all the branches of military technology and military technical work to attain the harmonious development of the offensive and defensive means of war.

Soviet military science teaches that only given the harmonious development of all forms of military technology

and all spheres of military science, and given the comprehensive coordination of military science with all civilian sciences, is it possible in modern conditions to attain very high fighting qualities of all the armed forces.

Sciences Assuring the Defense of the Country

Contemporary science is created by the collective labor of a significant number of persons. Moreover, the level of development of science, as a whole, depends on the level of the development of the productive forces of the country. Consequently, any science in the last analysis is the result of the creative activity of the whole people.

Contemporary military affairs demand participation in the defense of the country, in addition to the army and the navy, of a whole quantity of workers, technicians, engineers and scientists. Every fighter is in complete fighting readiness only when many persons working in industry, agriculture, transport and in scientific institutes assure his military preparation and armament.

The development of modern powerful means of mass destruction has led to the circumstances that targets accurately located on the map can be destroyed quickly and by surprise more than ever.

If these targets are dispersed, mobile, and well masked, then the new means of mass destruction, for example, atomic bombs, are then less effective or even completely ineffective against them. Therefore, in modern conditions a mass army relying on the whole people and provisioned by the whole people is a more important condition for the defensive potential of the country than ever before. In this regard, the socialist system has tremendous superiorities as a matter of principle over capitalist systems.

In order for the army and the people to best be able to secure the defense of the socialist government it is necessary that they know the tasks and purposes of war and master the necessary knowledge of military affairs. The military and military technical education of wide masses of the population is now a necessary basis of the defense of the country and its readiness for all surprises.

In such conditions the dissemination of military knowledge is an important form of defensive work and deserves wide development and intensification.

In conclusion it should be said that no matter how technology develops, which lightens the execution of military tasks for the person, there are no conditions in which it leads to the reduction of the demands placed by war on the physical

and moral endurance of the human being. What is more, as technology grows, the demands on the individual also grow. Let us just take, as an example, a pilot completing a flight in a high-flying and fast aircraft. Of necessity, he should be able to get out in a parachute, which at great speeds and at great heights demands from a human being a tremendous endurance and rapidity of reflexes attained by systematic training.

A pilot flying an aircraft at supersonic speeds cannot leave it by ordinary means. He must be ejected from the aircraft by means of a powerful machine (catapult)... similar to a shell. Moreover, the pilot experiences the pressure of very powerful forces. In order to survive this without injury, special training is necessary. Special training mechanisms have been created which permit the reproduction in appropriate laboratory conditions of the forces which are active at catapulting.

As the result of the great height, the air pressure is reduced and the flier's organism can suffer a number of morbid changes in a high flight. The study of the biological processes in the human organism at great heights and training for preparation for high flying is conducted in pressure chambers where the pressure, temperature and air humidity can be changed.

The biological and medical sciences have very great significance, not only...for physical training. These sciences permit the control of the physical condition of the human being in the execution of physical labor or other physical strains.